UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

JUN 26 2015

Mr. Thomas Frick
Director
Division of Environmental Assessment & Restoration
Florida Department of Environmental Protection
Mail Station 3000
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Dear Mr. Frick:

The U. S. Environmental Protection Agency has completed its review of the numeric interpretation of the state narrative nutrient criterion (NNC) for total nitrogen (TN) and total phosphorus (TP) for Lake Cypress (WBID 3180A), Lake Marian (WBID 3184), Lake Jackson (WBID 3183G), Lake Kissimmee (WBID 3183B) and Lake Holden (WBID 3168H). The Florida Department of Environmental Protection submitted revised Chapter 62-303, Florida Administrative Code (F.A.C.) including the NNC for the subject waters, to the EPA on July 28, 2014, as new or revised water quality standards (WQS) with the necessary supporting documentation and certification by FDEP General Counsel, pursuant to 40 CFR 131. The NNC were adopted under Chapter 62-303.515(1)-(5) as site specific numeric interpretations of paragraph 62-302.530(47)(b), F.A.C., as referenced in paragraph 62-302.531(2)(a), F.A.C. The FDEP intends for the submitted NNC to serve in place of the otherwise, applicable criteria set out in paragraph 62-302.531(2)(b), F.A.C.

In accordance with section 303(c) of the Clean Water Act, I am hereby approving the NNC for Lake Holden (WBID 3168H), Lake Cypress (WBID 3180A), Lake Marian (WBID 3184), Lake Jackson (WBID 3183G) and Lake Kissimmee (WBID 3183B) as revised WQS for TN and TP. Any other criteria applicable to this waterbody remain in effect, especially those related to chlorophyll *a* in paragraph 62-302.5312.(b)1., and including other applicable criteria at 62-302.531(2)(b). The requirements of paragraph 62-302.530(47)(a), F.A.C. also remain applicable. The details of the NNC are discussed in the enclosed documentation.

We would like to commend you and your staff for your continued efforts in environmental protection for the State of Florida. If you have any questions regarding the EPA's approval, please contact me at (404) 562-9345 or have a member of your staff contact Ms. Cecelia Ann Harper, in the Water Quality Standards Section at (404) 562-9418.

Sincerely,

Gale Mitchell, for

James D. Giattina
Director
Water Protection Division

cc: Mr. Craig D. Varn, FDEP
Mr. Eric Shaw, FDEP

Enclosure

Decision Document for the Hierarchy 1 Site Specific Numeric Interpretation of the Narrative Nutrient Criteria for Lake Cypress, Lake Marian, Lake Jackson, Lake Kissimmee and Lake Holden

INTRODUCTION

In a letter dated July 28, 2014, from Matthew Z. Leopold, General Counsel for Florida Department of Environmental Protection, to Heather McTeer Toney, Regional Administrator of the EPA's Region 4 Office, FDEP submitted to the EPA for review numeric interpretations of the state narrative nutrient criteria included in the Lake Cypress, Lake Marian, Lake Jackson, Lake Kissimmee, and Lake Holden Total Maximum Daily Loads (TMDL). These Hierarchy 1 (H1) interpretations through TMDLs are intended to serve as the primary site specific interpretations of Florida's narrative water quality criterion for nutrients set out in paragraph 62-302.530(47)(b), Florida Administrative Code (F.A.C.), in accordance with paragraph 62-302.531(1)(a), F.A.C. In addition, as required by the Clean Water Act (CWA), by letter dated July 28, 2014, FDEP General Counsel certified that the revised water quality standards (WQS) were duly adopted pursuant to Florida law. This decision document approves the H1 interpretations through TMDLs as discussed further below.

Clean Water Act Requirements

Section 303 of the CWA, 33 U.S.C. § 1313, requires states to establish WQS and to submit any new or revised standards to the EPA for review and approval or disapproval. The EPA's implementing regulations require states to adopt water quality criteria that protect the designated use. See 40 C.F.R. 131.11(a). Such criteria must be based on a sound scientific rationale and must contain sufficient parameters or constituents to protect the designated use. Id. For waters with multiple use designations, the criteria shall support the most sensitive use. Id. In addition, the EPA's regulations require that in establishing criteria, a state shall consider WQS of downstream waters and shall ensure that its WQS provide for the attainment and maintenance of WQS of downstream waters. See 40 C.F.R. 131.10(b). A state's submission of water quality criteria must include (1) the methods used and analyses conducted to support WQS revisions, (2) water quality criteria sufficient to protect the designated uses and (3) a certification by the State Attorney General or other appropriate legal authority within the state that the WQS were duly adopted pursuant to state law. See 40 C.F.R. 131.6.

Endangered Species Act Requirements

In addition to the EPA's review pursuant to section 303 of the CWA, section 7(a)(2) of the Endangered Species Act (ESA) requires federal agencies, in consultation with the Fish and Wildlife Service (FWS), to ensure that their actions are not likely to jeopardize the continued existence of federally listed species or result in the destruction or adverse modification of designated critical habitat of such species.

With regard to consultation activities for section 7 of the ESA, the EPA Region 4 transmitted a Biological Evaluation to the Jacksonville, and Vero Beach FWS field offices in a letter dated March 18, 2015. The EPA received concurrence from the Jacksonville FWS office in a letter dated April 21, 2015, and the Vero Beach FWS office in a letter June 10, 2015.

EPA's DECISION

Each of FDEP's site specific criteria for total nitrogen (TN) and/or total phosphorus (TP) approved by this action are listed below by waterbody name. Any other criteria applicable to these waterbodies remain in effect. Especially, specific to nutrients, (1) the chlorophyll *a* criterion value of 20 µg/L as an annual geometric mean for lakes with a color value greater than 40 Platinum Cobalt Units (PCUs) and lakes with a color value less than or equal to 40 PCUs and greater than 20 mg/L $CaCO_3$, or (2) a criterion value of 6 µg/L as an annual geometric mean, for lakes with a color value less than or equal to 40 Platinum Cobalt Units and less than or equal to 20 mg/L $CaCO_3$ continues to apply and is consistent with the requirements of paragraph 62-302.531(2)(b)1., F.A.C.

In addition, the requirement of paragraph 62-302.530(47)(a), F.A.C. also continues to apply. Paragraph 62-302.530(47)(a) provides that "[t]he discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. Man-induced nutrient enrichment (total nitrogen or total phosphorus) shall be considered degradation in relation to the provisions of Rules 62-302.300, 62-302.700, and 62-4.242, F.A.C."

Waterbody Name	WBID	Waterbody Description Class	Listing Parameter	Chapter 62-304 Language	Approved Site Specific Interpretation of the NNC
Lake Cypress	3180A	Lake Class III Freshwater High Color	Nutrients (TSI)	62-304.515 "(2) Lake Cypress: The nutrient TMDL for Lake Cypress is 1,374,801 lb/year of TN and 51,175 lb/year of TP"	TN = 1,374,801 lbs/yr TP = 51,175 lbs/yr Not to be exceeded at any time.
Lake Marian	3184			62-304.515 "(3) Lake Marian: The nutrient TMDL for Lake Marian is 88,122 lb/year of TN and 6,013 lb/year of TP"	TN = 88, 122 lbs/yr TP =6,013 lbs/yr Not to be exceeded at any time.
Lake Jackson	3183G			62-304.515 "(4) Lake Jackson: The nutrient and dissolved oxygen (DO) TMDL for Lake Jackson is 118,662 lb/year of TN and 5,553 lb/year of TP"	TN = 118,662 lbs/yr TP =5,553 lbs/yr Not to be exceeded at any time.
Lake Kissimmee	3183B			62-304.515 "(5) Lake Kissimmee: The nutrient TMDL for Lake Kissimmee is 2,795,484 lb/year of TN and 126,517 lb/year of TP"	TN = 2,795,484 TP =126,517 Not to be exceeded at any time.
Lake Holden	3168H	Lake Class III Freshwater Low Color		62-304.515 "(1) Lake Holden: The nutrient total maximum daily load (TMDL) for Lake Holden is 148 lb/year of total phosphorus (TP) and 10,526 lb/year of total nitrogen (TN)"	TP = 148 lbs/yr TN = 10,526 lbs/yr Not to be exceeded at any time.

Technical Approaches Used to Derive Numeric Nutrient Criteria

1. Trophic State Index

The TN and TP loadings for Lake Cypress, Lake Marian, Lake Jackson and Lake Kissimmee were derived using a referenced based approach using data from 34 reference lakes across the State of Florida to show that the Tropic State Index (TSI) of lakes with minimum human impact vary naturally within a specified range. For the analysis, only lakes that had a land use area weighted average watershed Land Disturbance Index score less than 3.0 were used to calculate the long-term mean annual average TSI. The lakes were also divided into groups of high color (greater than 40 PCU) and low color (less than or equal to 40 PCU). The results of the analysis indicated that the 25th percentile of the distribution of standard deviation for both lake categories is approximately 5 TSI units, demonstrating that adding 5 TSI units to the modeled background TSI is within the low end of the range for natural TSI variation in lakes across Florida. The final calculated number (modeled background TSI plus 5 TSI units) represents the natural background TSI value.

More broadly applied, one measure of impairment in lakes set out in the Impaired Waters Rule is a 10 unit change in TSI from "historical" levels. This 10 unit increase is assumed to represent the transition of a lake from one trophic state (e.g., mesotrophic) to another nutrient enriched condition (e.g., eutrophic). FDEP's technical approach for criteria development outlined above determined that an increase in 5 TSI units would not result in a lake changing its trophic state. Based on that analysis, background value plus 5 TSI units represent the final TSI value used to derive TN and/or TP loadings for each lake.

EPA Analysis

The EPA determined that the technical modeling approach used by the State to determine natural background TSI is an appropriate and defensible method and that the addition of TSI units to modeled natural background TSI values, as calculated by the State, is also a reasonable and appropriate approach for the lakes addressed by this approval action. This approach is further supported by the document "Using the Trophic State Index Tool to Establish Nutrient Targets for Lake TMDLs That Are Protective of Designated Uses" (Attachment 1) provided by the State and summarized above. The TN and TP loadings derived from TSI values that constitute natural background plus additional TSI units to account for natural variability, as presented in each waterbodies' TMDL, represent levels at which a balance in flora and fauna will occur and are therefore protective of the lakes' designated uses and downstream waters.

Further, the models FDEP utilized to derive the nutrient loadings, which serve as NNC, are scientifically defensible mechanistic models developed by or for the EPA including the Water Management Model and Hydrologic Simulation Program Fortran (HSPF) model.

Lake Cypress

Lake Cypress is located in Osceola County, Florida. The estimated average surface area of the lake is 4,100 acres, with a normal pool volume between 14,400 and 29,027 ac/ft, and an average depth ranging from 3.5 to 7.1 feet. Lake Cypress receives drainage from 352,430 acres through tributary inflow and has a directly connected sub-basin surface water drainage area of approximately 16,175 acres, for a total watershed area of 368,605 acres. Lake Cypress receives the outflows from Lake Tohopekaliga through the S61S structure and C35 canal and from Lake Gentry through the S63S structure and C34 canal, and

discharges to Lake Hatchineha by way of C36 canal, which discharges to Lake Kissimmee by way of a canal through the inflow structure C37. Lake Kissimmee discharges through outflow structure S65 to the Kissimmee River, which flows to Lake Okeechobee.

Waterbody Name	WBID	Waterbody Description Class	Listing Parameter	Chapter 62-304 Language	Approved Site Specific Interpretation of the NNC
Lake Cypress	3180A	Lake Class III Freshwater High Color	Nutrients (TSI)	62-304.515 "(2) Lake Cypress: The nutrient TMDL for Lake Cypress is 1,374,801 lb/year of TN and 51,175 lb/year of TP"	TN = 1,374,801 lbs/yr TP = 51,175 lbs/yr Not to be exceeded at any time.

Lake Marian

Lake Marian is located in Osceola County, Florida. The estimated average surface area of the lake is 6,553 acres, with a normal pool volume of 46,819 ac/ft and an average depth of 13 feet. Lake Marian is an open hydrologic system that receives drainage from a directly connected area of approximately 35,437 acres. The lake receives runoff from the local basin and discharges through the G113 outflow structure to Lake Jackson by way of a canal. Lake Jackson discharges through the G111 outflow structure to Jackson Canal, which flows to Lake Kissimmee. Lake Kissimmee discharges through outflow structure S65 to the Kissimmee River, which flows to Lake Okeechobee.

Waterbody Name	WBID	Waterbody Description Class	Listing Parameter	Chapter 62-304 Language	Approved Site Specific Interpretation of the NNC
Lake Marian	3184	Lake Class III Freshwater High Color	Nutrients (TSI)	62-304.515 "(3) Lake Marian: The nutrient TMDL for Lake Marian is 88,122 lb/year of TN and 6,013 lb/year of TP"	TN = 88, 122 lbs/yr TP =6,013 lbs/yr Not to be exceeded at any time.

Lake Jackson

Lake Jackson is located in Osceola County, Florida. The estimated average surface area of the lake is 1,123 acres, with a normal pool volume of 7,223 ac/ft and an average depth of 9 feet. Lake Jackson receives drainage from 35,437 acres through tributary inflow (through a canal from the G113 outflow structure in Lake Marian) and has a directly connected sub-basin surface water drainage area of approximately 21,894 acres, for a total watershed area of 57,331 acres. The lake receives runoff from the local basin and Lake Marian, and discharges through the G111 outflow structure and Jackson Canal to Lake Kissimmee. Lake Kissimmee discharges through outflow structure S65 to the Kissimmee River, which flows to Lake Okeechobee.

Waterbody Name	WBID	Waterbody Description Class	Listing Parameter	Chapter 62-304 Language	Approved Site Specific Interpretation of the NNC
Lake Jackson	3183G	Lake Class III Freshwater High Color	Nutrients (TSI)	62-304.515 "(4) Lake Jackson: The nutrient and dissolved oxygen (DO) TMDL for Lake Jackson is 118,662 lb/year of TN and 5,553 lb/year of TP"	TN = 118,662 lbs/yr TP =5,553 lbs/yr Not to be exceeded at any time.

Lake Kissimmee

Lake Kissimmee is located in Osceola County, Florida. The estimated average surface area of the lake is 37,000 acres, with a normal pool volume ranging between 216,000 ac/ft and 368,000 ac/ft with normal depths ranging between 8 and 12 feet. Lake Kissimmee receives the drainage from 831,208 acres

through tributary inflow (from Lake Hatchineha by canal through inflow structure C37, from Lake Rosalie and Tiger Lake by canal through inflow structure G103, and from Lake Jackson through outflow structure G111 and Jackson Canal) and has a directly connected sub-basin surface water drainage area of approximately 70,321 acres for a total watershed area of 901,529 acres. Lake Kissimmee discharges through outflow structure S65 to the Kissimmee River, which flows to Lake Okeechobee.

Waterbody Name	WBID	Waterbody Description Class	Listing Parameter	Chapter 62-304 Language	Approved Site Specific Interpretation of the NNC
Lake Kissimmee	3183B	Lake Class III Freshwater High Color	Nutrients (TSI)	62-304.515 "(5) Lake Kissimmee: The nutrient TMDL for Lake Kissimmee is 2,795,484 lb/year of TN and 126,517 lb/year of TP"	TN = 2,795,484 TP =126,517 Not to be exceeded at any time.

2. Multiple Lines of Evidence

FDEP typically uses natural background land use predictions to develop TMDL loads or concentrations for lakes as described above; however, this approach was not used for Lake Holden because the calibration would have included the simulation of internal loading and stormwater treatment by three alum injection facilities that made the results from a simple land use substitution to the background condition unreliable.

Instead, FDEP relied on site specific information, an extensive literature review and an analysis of data summarized in the EPA Technical Support Document (TSD) (EPA 2009b) and FDEP draft TSD 2009 to develop the loading values. The EPA documented in TSD EPA 2009b that there are different correlations between nitrogen and phosphorus and the biological response parameter chlorophyll *a* (chl *a*) in the different lake types located in Florida. These differences were specific, significant, and documentable when considered in combination with additional lines of evidence.

In addition, paleolimnological studies conducted for Florida lakes with low color indicated that the average chl *a* values would naturally range between 14 and 20 µg/L. Considering these multiple lines of evidence, FDEP used a concentration of 14 µg/L, that is at the lower end of the range suggested by the paleolimnological studies (14 µg/L and 20 µg/L), for Lake Holden. The HSPF model was run with increasing levels of watershed nutrient reductions until the in-lake chl *a* concentration fell below 14 µg/L. The TMDL for Lake Holden was then expressed as the TN and TP watershed loads required to restore the lake to support natural flora and fauna.

EPA Analysis

The EPA determined that the technical approaches used by the State to determine site specific TSI are appropriate and defensible methods. These approaches included an extensive literature search including comparisons from other states, use of the EPA developed approaches and FDEP paleolimnological studies. Further, using the low end of the chl *a* range provides a conservative approach for determining the appropriate chl *a* value that will provide for the balance of flora and fauna required to protect Lake Holden's designated uses and downstream waters.

Lake Holden

Lake Holden is located in Orange County, Florida, with portions of the drainage area extending into the City of Orlando. The estimated average surface area of the lake is 179 acres, with a normal pool volume of 1,140 acre/feet (ac/ft) and an average depth of 12 feet. Lake Holden receives drainage from a sub-

basin that is directly connected and approximately 766.4 acres in size. Overall, Lake Holden lies within a closed hydrologic basin that drains to several drainage wells located within the lake.

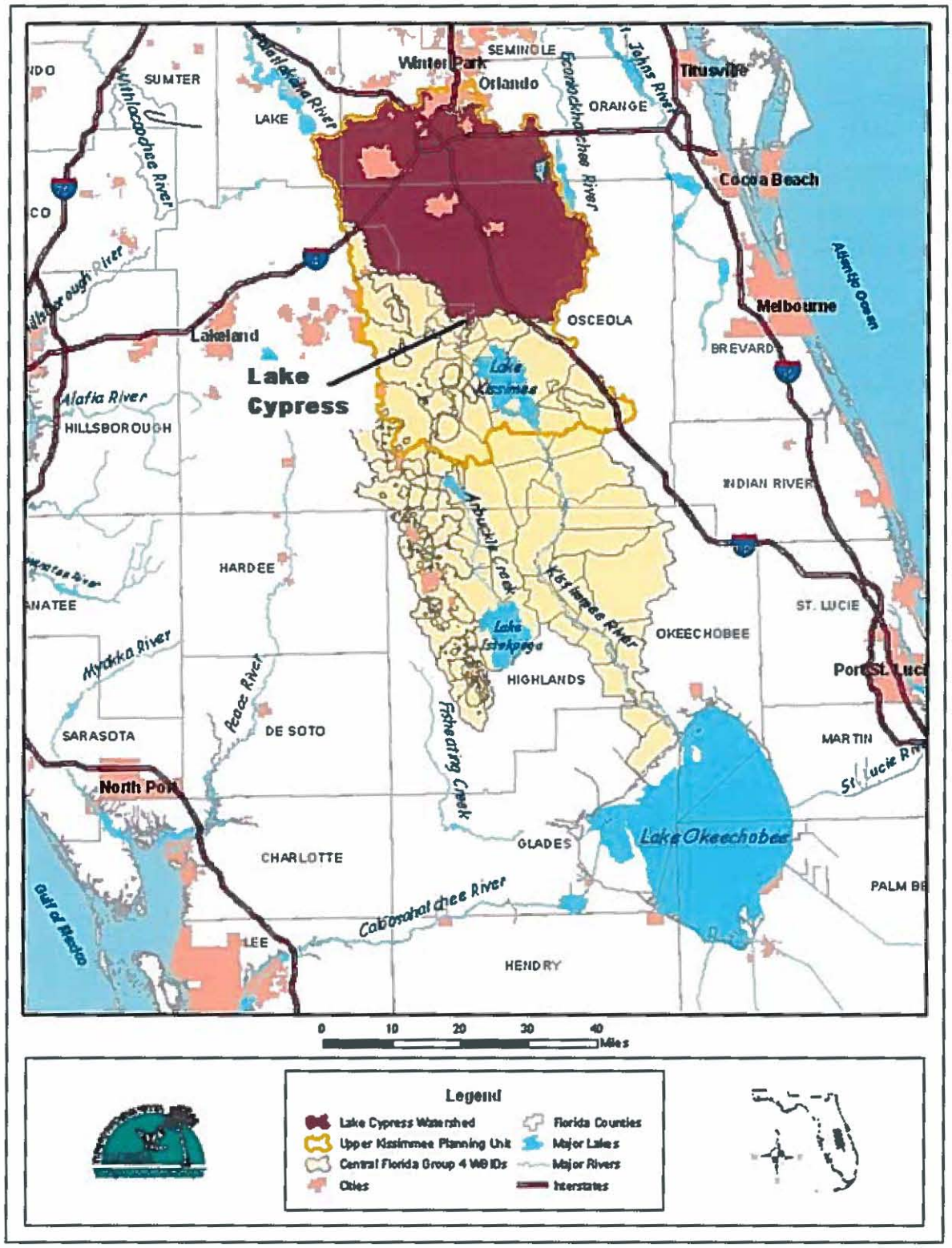
Waterbody Name	WBID	Waterbody Description Class	Listing Parameter	Chapter 62-304 Language	Approved Site Specific Interpretation of the NNC
Lake Holden	3168H	Lake Class III Freshwater Low Color	Nutrients (TSI)	62-304.515 "(1) Lake Holden: The nutrient total maximum daily load (TMDL) for Lake Holden is 148 lb/year of total phosphorus (TP) and 10,526 lb/year of total nitrogen (TN)"	TP = 148 lbs/yr TN = 10,526 lbs/yr Not to be exceeded at any time.

Conclusion

Based on the chemical, physical and biological data presented in the development of the H1 NNC's outlined above, the EPA concludes that all of the aforementioned H1 NNC's provide for and protect healthy, well-balanced biological communities in the waters to which the NNC's apply and are consistent with the CWA and its implementing regulations. More specifically, the NNC are consistent with both 40 CFR 131.11(b)(1)(ii), and the EPA's 304(a) guidance on nutrient criteria. In addition, paragraph 62-302.531(4), F.A.C. will apply in conjunction with all of the H1 NNC's addressed by this decision document in order to ensure attainment and maintenance of WQS of downstream waters, in accordance with 40 CFR 131.10. In accordance with section 303(c) of the CWA, the H1 NNC's addressed by this decision document, are hereby approved as consistent with the CWA and 40 CFR Part 131.

_____
Date

_____
James D. Giattina
Director, Water Protection Division



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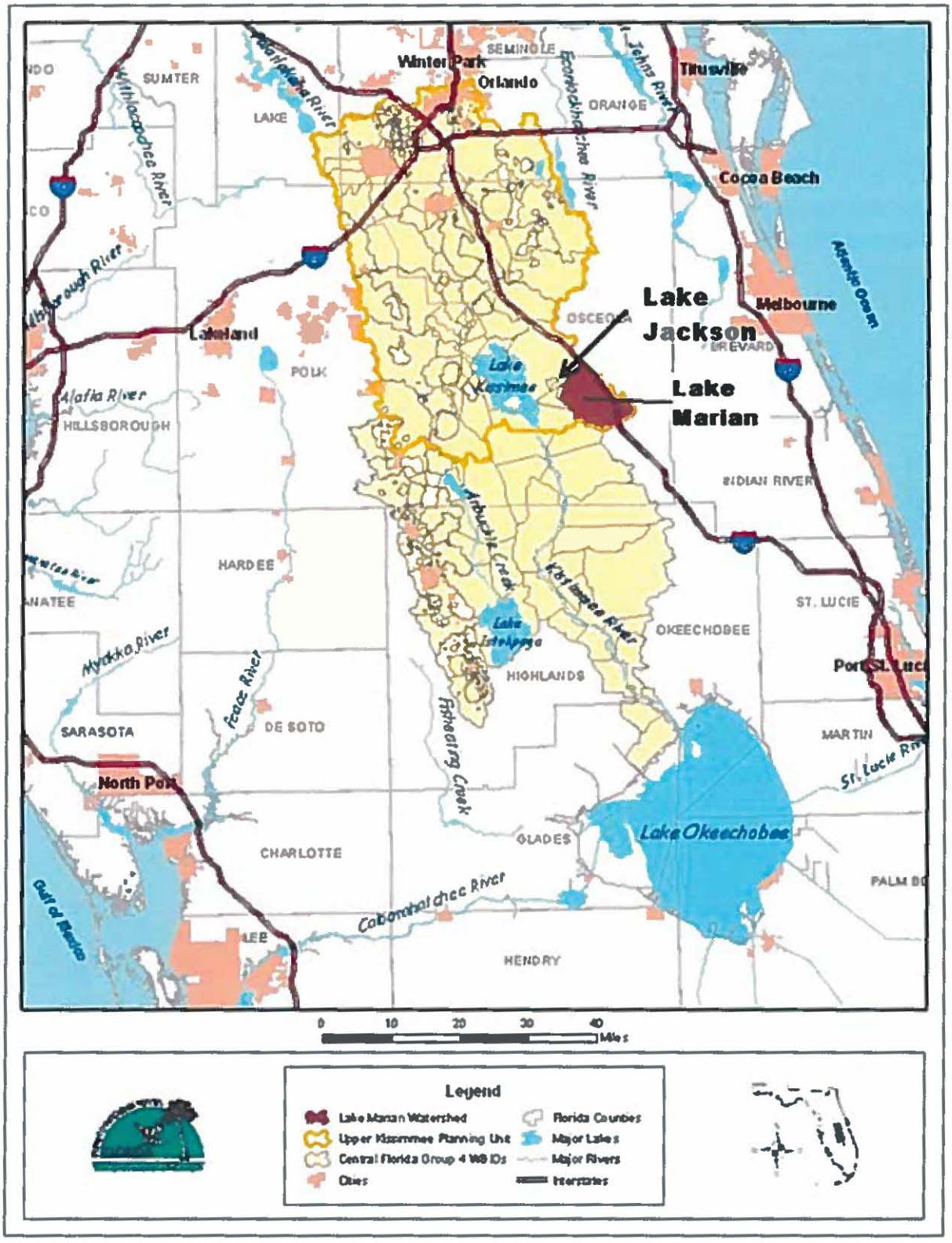

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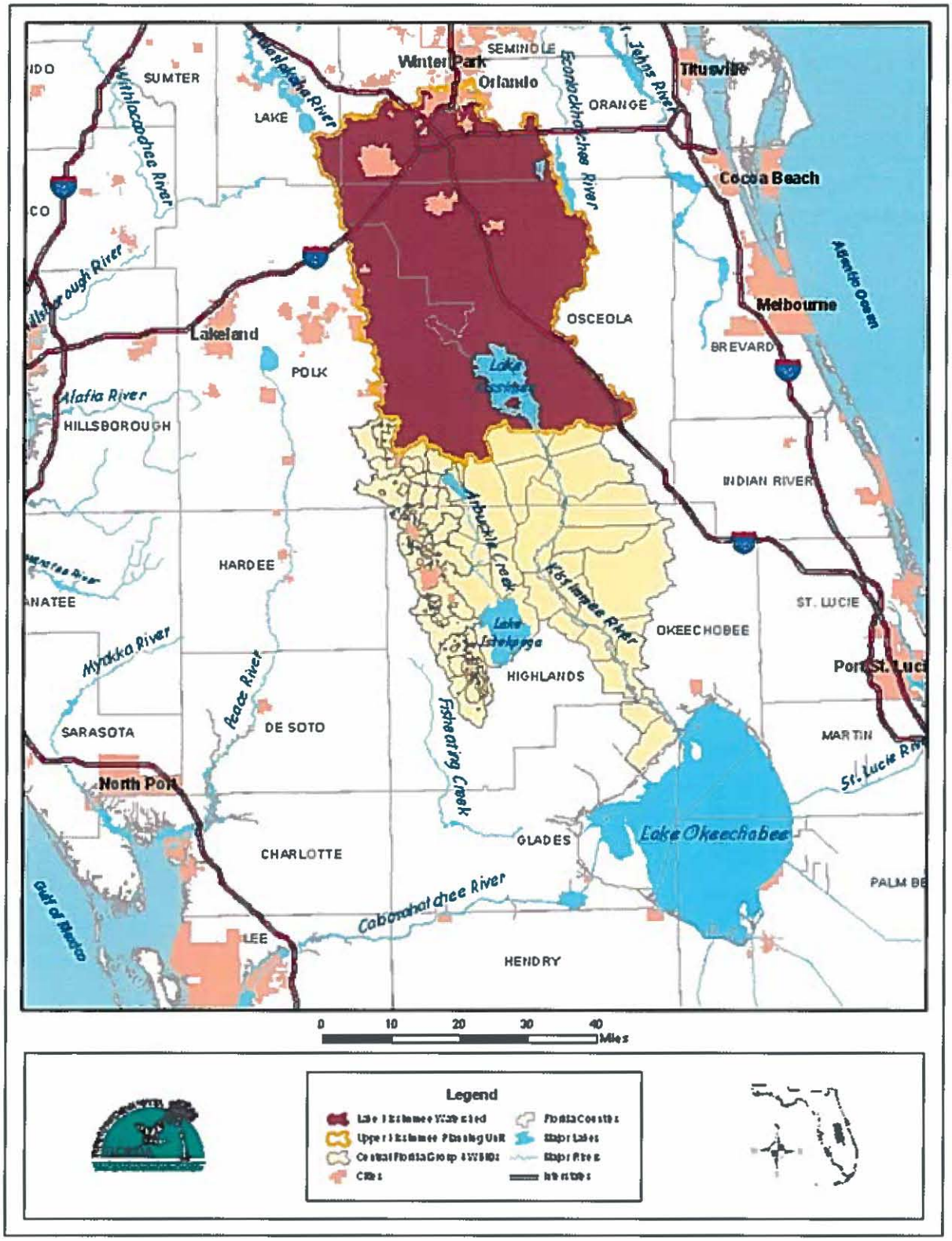

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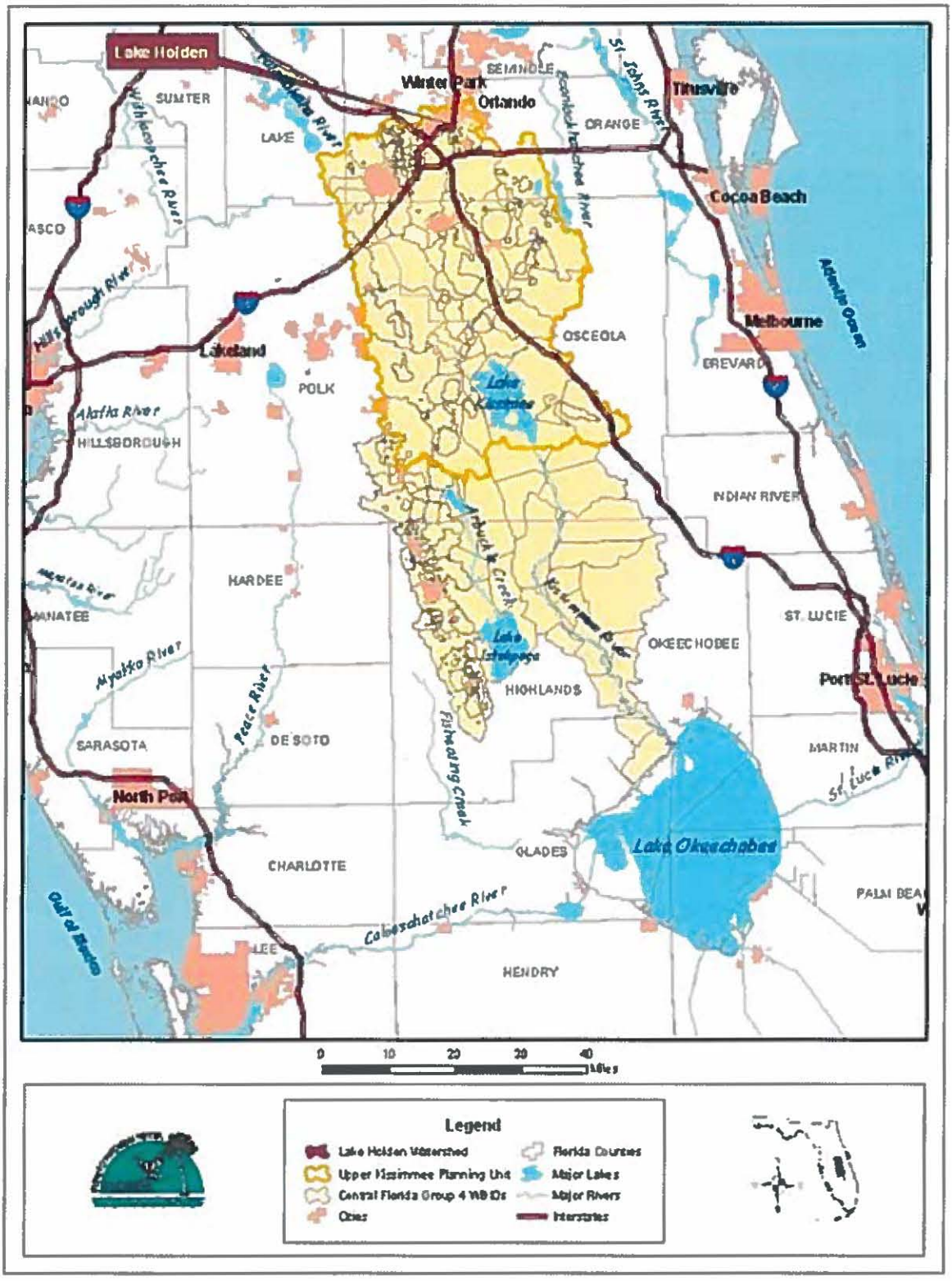

Lake Holden (WBID 3168H)

Attachment 1

ATTACHMENT 1

Using the Trophic State Index Tool to Establish Nutrient Targets for Lake TMDLs that are Protective of Designated Uses

These materials have been prepared in response to EPA Region 4's request for added documentation regarding the Florida Department of Environmental Protection's (FDEP) past use of the Trophic State Index (TSI) as part of the development process in setting nutrient targets for lake TMDLs For over ten years FDEP has used, among other approaches, the modeled Natural Background TSI plus no more than a 5 TSI unit increase to account for the natural variability of lakes and to establish TMDL targets that are protective of designated uses. Currently, Florida has approximately 15 adopted lake TMDLs that used this methodology to establish TMDL targets. EPA's major issues regarding these TMDLs are (1) whether the Natural Background TSI+5 TSI unit approach establishes protective nutrient targets and (2) whether the nutrient target established using the Natural Background TSI+5 TSI unit approach constitutes site specific nutrient targets.

To address EPA's comments, FDEP examined the distribution of the variation in TSI of 34 reference lakes located across the state to show that the TSI of lakes with minimum human impact vary naturally. For the analysis the lakes were divided into groups of high color (greater than 40 PCU) and low color (less than or equal to 40 PCU). The analysis indicated that the 25th percentile of the distribution of standard deviation for both categories of lakes is approximately 5 TSI units, suggesting adding 5 TSI units on top of the background TSI is not only within the natural range of TSI variation, but is at the lower end of the natural variation. Because the reference lakes used in these analyses are lakes located across the entire state, the variation observed for these lakes should apply to all the lake nutrient TMDLs that have been adopted by FDEP in the past using the Natural Background TSI+5TSI method. However, with the implementation of the numeric nutrient criteria (NNCs), the FDEP does not plan to use the Natural Background TSI+5TSI unit method for future lake TMDL development.

The previous FDEP methodology for using TSI is valid because the approach maintains the general natural trophic state of the waterbody, within the realm of natural variability of reference lakes within Florida. The trophic classification (whether oligotrophic, mesotrophic, or eutrophic) is based on a broad range of TSI values, and a single point of TSI will not shift the waterbody from one trophic state to another. Basing the targets for chlorophyll a (Chla), total phosphorous (TP), and total nitrogen (TN) on the natural background plus 5 TSI units maintains the lake within known variability of the natural trophic state, providing for maintenance of the natural conditions of the waterbody and a well-balanced population of natural flora and fauna.

(1) **Advantage of using TSI:**

The federally promulgated NNC currently in effect for Florida's freshwater lakes and springs are in the form of concentrations for Chla, TN, and TP. These lake criteria were

empirically derived from a statewide set of "typical" lakes that meet a certain set of characteristics of color and alkalinity. Dynamics of nutrients and their effects on response variables, e.g., Chla concentration, may vary greatly from waterbody to waterbody. When developing nutrient TMDLs for lakes, the preferred approach is always to consider as much local information as possible. In many cases, multiple lines of evidence, including lake trophic dynamics, paleolimnology records, watershed to receiving water relationships, water residence time, model simulated background condition, etc. can all be used in establishing robust nutrient targets that are fully protective of designated uses. Among these lines of evidence, the TSI can be applied as a valid and valuable tool in examining the nutrient dynamics in lakes.

As a valuable tool to characterize and classify lake nutrient dynamics, the TSI was originally based on a relationship tied to Secchi Depth. The index was developed in such a way that it has a numeric scale of 0 to 100. In many lakes, Secchi Depth showed a strong relationship related to the Chla concentration, which in turn is, in many cases, strongly related to TN and TP concentration. Based on these correlations, Chla-TSI, TN-TSI, and TP-TSI can all be calculated. This process brings Chla, TN, and TP under the same scale of 0 – 100, so that different aspects of the lake nutrient dynamic components can be compared to create insights for nutrient target setting (Carlson, 1977). The Chla-TSI, TN-TSI, and TP-TSI equations currently used by FDEP to calculate the lake specific composite TSI were established by Huber et al. (1982) after examining the Chla – nutrient relationships in more than 300 Florida lakes.

Because the Chla concentration and TN and TP concentrations are functionally related, one would expect that the TSI value calculated based on the Chla concentration (Chla-TSI) would generally be the same as the TSI calculated based on nutrient concentrations (Nutrient-TSI) if the major factors in a lake that control phytoplankton are nutrients. If the Chla TSI is significantly different from the nutrient-based TSI, there might be factors in the lake that depress or enhance the phytoplankton growth. These factors could be color, turbidity, water residence time, zooplankton grazing, or a range of chlorophyll/nutrient/ carbon ratios. The presence of certain algal species (e.g., nitrogen-fixers or microalgae) may also figure into the final target setting process. In addition, the TSI may also provide information regarding nutrient limitation in the lake. A nitrogen TSI much higher than the phosphorus TSI may suggest that nitrogen fixation is an important source of nitrogen for the lake, while a higher phosphorus TSI over the nitrogen TSI may imply an imbalanced nitrogen and phosphorus relationship due to internal loadings (sediment nutrient release) or ground water phosphorus input. In addition, the TSI provides a useful tool for selecting the desired trophic status among all competing designated uses. It has long been recognized that TSI often provides a very useful tool for setting up nutrient targets based on the hydraulic residence time of the receiving water (Vollenweider, R. A. and J. Kerekes, 1980). All of this information can be critical for setting the final nutrient targets.

(2) Natural Background TSI + 5 TSI Unit

This approach (natural background TSI+5 TSI) for establishing lake TMDL targets is appropriate where a model calibrated to current conditions (over a wide range of climatic conditions) can be used to establish with confidence the natural conditions for a lake.

In many cases, the model simulated TSI was used as one of several lines of evidence to set nutrient targets. Sometimes modeled TSI outcomes were used as the most important evidence to establish the water quality target for lack of other evidence and also because of the aforementioned information that the TSI can provide. In most cases, nutrient targets were established as model simulated natural background TSI plus 5 TSI units. As often also done by EPA, the natural background TSI may be simulated using watershed and receiving water models by converting all developed lands in the modeled watershed into upland forest and wetlands and removing all point sources and other sources such as septic tanks. Multiple years of annual average natural background TSIs are usually simulated and a long-term mean annual average TSI value is usually calculated for nutrient target setting purposes.

Because the long-term mean annual average natural background TSI represents a central tendency of the background condition, it is expected that the long-term mean annual average TSI will be exceeded at least 50% of the time, even under the background condition. This is because nutrient and Chla concentrations vary naturally, even under the natural background condition. In order to address the natural variation and avoid incurring too high an instance of Type I errors when establishing the nutrient targets, a certain amount of fluctuation should be allowed above the mean natural background condition. A practice used by FDEP in the past ten years in developing lake nutrient TMDLs is to add 5 TSI units on top of the background condition to set the nutrient target. Adding 5 TSI units on top of the model simulated background TSI provides a mechanism to address the variation of nutrient and Chla concentrations in natural lakes.

(3) Natural Variability of TSI in Reference Lakes

For the analysis, FDEP decided to determine the natural variability of minimally disturbed or reference lakes from across the state. The criteria used to identify reference lakes for this analysis was that the area-weighted Landscape Development Intensity (LDI) score for the watershed of selected lakes is less than 3.0. LDI scores less than 3.0 indicate natural areas with minimal landscape disturbance or urban development. As requested by EPA, FDEP separated these reference lakes into groups based on the color and alkalinity attributes that were used in the adopted NNC. Below are the general procedures that were used to subset the reference lakes.

Utilizing ArcGIS application, all lake WBIDs across the State of Florida were searched for WBIDs that only include land use types with an LDI score of less than 3.0. These lakes were further examined to find those lakes whose surrounding areas are mostly

land use types with LDI scores of less than 3.0. This was the group of candidate reference lakes selected for watershed delineation.

Once the watersheds were delineated, the land use area-weighted average watershed LDI scores were calculated and only those lakes with an LDI score less than 3.0 were selected for the next step.

This set of selected reference lakes was then used in a query of the Impaired Waters Rule (IWR) database to retrieve data for color, alkalinity, Chla, TN, and TP. Those lakes that did not have any Chla, TN, and TP data or do not have sufficient Chla, TN, and TP data for calculating TSI for at least three years were removed from the list. The remaining lakes on the list were then checked against the lake WBIDs included on the FDEP Verified List to ensure none of the selected lakes were verified for nutrient impairment. The remaining reference lakes were used in the analysis of the variation of long-term annual average TSI for statewide reference lakes. **Table 1** shows the WBID number, the land use area-weighted watershed LDI score, the number of years that Chla, TN, and TP data are available for calculating the annual average TSI, the long-term average color, alkalinity, Chla, TN, and TP concentrations, the long-term mean annual average TSI, and the standard deviation of TSI for each reference lake WBID.

The reference lakes included in **Table 1** were divided into two groups based on their long-term average color values. Those lakes with the long-term mean color value less than or equal to 40 platinum cobalt unit (PCU) were considered low color lakes while those lakes with the long-term mean color value higher than 40 PCU were considered high color lakes (highlighted using yellow color).

Table 1 Reference Lake Characteristics

WBID	Watershed Land Use Area Weighted LDI	Number of Years	Long-term Average Color (pcu)	Long-term Average Alk (mg/L)	Long-term Mean Annual Average ChlaC (ug/L)	Long-term Mean Annual Average TN (mg/L)	Long-term Mean Annual Average TP (mg/L)	Long-term Mean Annual Average TSI	Annual Average TSI Standard Deviation
795A	1.9	9	5.89		1.07	0.23	0.007	17.6	2.4
783A	1.4	4	6.25		3.15	0.18	0.005	20.0	6.4
2918G	1.2	15	6.36	1.35	1.20	0.13	0.006	13.9	6.1
526B	2.0	4	8.54	1.00	2.76	0.18	0.005	17.9	7.1
516	1.8	4	8.92		1.28	0.33	0.006	19.6	1.9
555	2.0	3	9.78	16.79	2.43	0.35	0.005	19.1	4.6
662	1.7	5	11.00	1.00	1.29	0.29	0.007	18.3	5.5
526A	1.7	3	13.75	1.00	4.15	0.36	0.004	19.4	8.7
226	1.6	4	14.38	20.00	2.06	0.20	0.005	17.6	4.9
2541	1.6	12	18.34	2.30	3.01	0.26	0.025	31.6	5.4
2596A	1.4	3	18.89	1.75	2.35	0.40	0.017	31.6	1.9
2905C	1.0	6	22.13	2.43	4.26	0.37	0.015	33.3	7.3
83A	1.1	4	23.65	9.63	19.37	0.72	0.035	52.9	6.4
204A	1.7	3	28.33	1.00	1.92	0.42	0.007	23.0	7.3
145	1.0	3	28.61	8.38	11.79	0.64	0.026	45.6	12.0
3635A	2.3	8	32.73	1.70	2.42	0.61	0.014	32.6	4.9
3598D	2.5	9	35.93	19.80	2.44	0.72	0.039	36.8	4.3
239A	2.3	4	37.25	12.24	4.53	0.30	0.011	25.4	14.5
179A	1.2	5	40.00	14.54	20.11	0.80	0.040	55.3	4.5
3176	1.8	23	61.61	7.50	3.27	0.68	0.017	37.3	4.9
2339	1.3	8	65.23	29.55	3.47	0.51	0.069	35.8	8.9
3566	1.9	7	72.53	7.54	3.43	0.70	0.024	36.9	6.5
791N	2.1	13	74.54	4.96	8.58	0.76	0.032	44.4	10.1
2392	1.4	7	75.05		6.66	0.68	0.023	41.8	9.0
3472	1.2	4	79.78	1.95	18.26	1.57	0.025	48.8	17.0
3176A	2.2	7	93.00	3.98	3.95	0.87	0.024	42.2	4.1
3174E	2.2	8	100.95	4.13	5.34	1.08	0.037	46.2	5.2
3174D	2.2	8	164.54	4.13	5.92	1.12	0.047	47.9	6.2
1165A	1.2	5	225.85	16.41	15.99	0.85	0.056	48.2	13.9
3171A	2.2	16	248.26	3.00	4.30	1.60	0.026	43.0	4.5
2771A	1.2	3	271.22	63.92	4.58	1.32	0.056	45.8	6.3
2775C	2.1	4	325.00	13.75	6.48	1.48	0.121	51.9	5.8
3530B	1.4	8	329.50	1.00	8.90	1.26	0.073	51.7	7.1
2775F	1.7	5	503.33	15.29	4.38	1.90	0.077	50.7	3.2

The expected range of natural variability in average annual TSI was evaluated by using the distribution of the standard deviations of the annual average TSI values in the reference lakes and by lake group. Specifically, FDEP calculated the 25th percentile, median, 75th percentile, and mean values of the standard deviations (of annual average TSI) for each reference lake group (i.e., high and low color lakes). A summary of these results is provided in **Table 2.**

Table 2
Natural Variation of TSI

Color	25th	Median	Mean	75th
Low	4.6	5.5	6.1	7.2
High	5.1	6.3	7.5	9.0

As shown by these results, the 25th percentile of the standard deviations of the annual average TSIs are 4.6 units and 5.1 units for low color and high color lakes, respectively, which are both very close to 5 TSI units and can both be rounded to 5 TSI units. In addition, the median and mean TSI standard deviation of both low color and high color lakes are higher than 5 TSI units. This shows that even reference lakes with minimum human disturbance have significant natural variation and using the long-term mean as the TMDL target would have a very high chance of Type I error. The 5 TSI units that were added on top of the long-term mean for the natural background conditions represents the low-end of the variation (near the 25th percentile), indicating that adding 5 TSI units on top of the natural background TSI is very conservative.

In addition, the distributions of the standard deviations of the annual average TSIs for both high and low color reference lakes are very similar and, therefore, should be considered applicable to the background condition for all lakes. This indicates that adding 5 TSI unit on top of the background TSI not only is protective, but should also maintain the site specific nature of the nutrient target defined by the background condition simulated specifically for each lake. Therefore, the nutrient targets established by Natural Background TSI+5TSI unit approach is both protective and site specific.

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Landscape Development Intensity Index (LDI)

http://www.dep.state.fl.us/water/bioassess/ldi-hdg-bcg.htm

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